Evaluating *Cryptosporidium* and *Giardia* in Urban Stormwater

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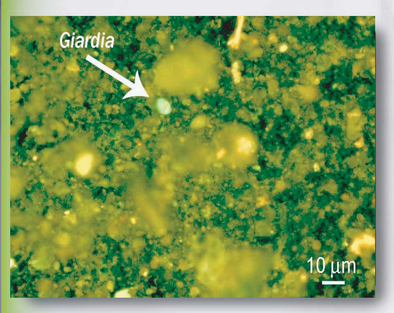
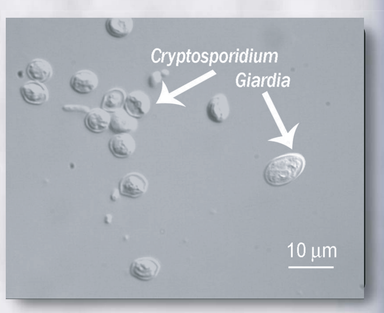
Abstract

Since the first identified *Cryptosporidium* outbreaks occurred in the 1980s and the massive Milwaukee Wisconsin outbreak of 1993 affecting over 400,000 people (Fox and Lytle, 1996), emerging protozoan pathogens *Cryptosporidium* and *Giardia* have become the subject of growing local, state, and national concerns. *Cryptosporidium* and *Giardia*, found in streams, rivers, ground water, and soil form hardy, disinfection-resistant oocysts and cysts. Both organisms are recognized causative agents of gastrointestinal illnesses linked to the consumption of contaminated surface or ground water.



Fluorescein Isothiocyanate (FITC) stained Giardia cyst embedded in stormwater particulates. Photo Credit: Irwin Katz, US EPA



Differential Interference Contrast images of Cryptosporidium oocysts and Giardia cysts showing internal structures. Photo Credit: Irwin Katz, US EPA

Introduction

This study evaluates *Cryptosporidium* and *Giardia* in stormwater as a threat to drinking water supplies. Four stormwater outfall sites were sampled and analyzed for *Cryptosporidium* and *Giardia* during two storm events each. Sample locations are classified by the United States Geological Survey (USGS) as high density residential (65% impervious), low density residential (17% impervious), landscaped/commercial and industrial where approximately 15% of the total area is vegetated, and wooded area with nearly 100% pervious landcover. Previous results found urban combined sewer overflow not to be a significant source for *Cryptosporidium* and to be a significant source for *Giardia* (Arnone *et al.* 2003)

This ongoing cooperative effort between the Office of Research and Development and EPA Region 2 is determining the detection frequency and concentration of *Cryptosporidium* and *Giardia* in stormwater. This data is useful to drinking water treatment plants located downstream of stormwater outfalls during times of wet weather for determining the potential geometric mean concentration of these parasites in treatment plant intake. U.S. EPA Method 1623 (US EPA 2001) is used for *Cryptosporidium* and *Giardia* analysis.

Objectives

The purpose of this project is to determine the concentrations of *Cryptosporidium* and *Giardia* in stormwater runoff. The results of this study will contribute to the ability to estimate the contribution of *Cryptosporidium* and *Giardia* from stormwater sources to receiving waters. A secondary objective is to determine the method variability and cyst/oocyst recoveries when analyzing stormwater using a surface water analytical method (EPA Method 1623).

Design and Methods

Samples are collected from two storm events at each of four stormwater discharge locations. Locations are classified according to the USGS level of pervious landuse (Table 1).

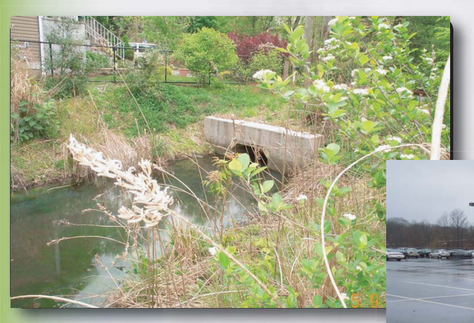
A dry period of at least 72 hours must occur prior to sampling.

Manual sampling conducted at all locations.

EPA Region 2 laboratory analyzed samples in quadruplicate to measure *Cryptosporidium* and *Giardia* using Method 1623, 10-Liter samples examined per replicate sample.

Table 1 Locations

Location	Land Use	Status
Staten Island, NY	High Density Residential	Completed
Edison, NJ	Landscaped Commercial	Completed
Holmdel, NJ	Low Density Residential	50% completed
Edison, NJ	Wooded Area	Completed



Staten Island, NY

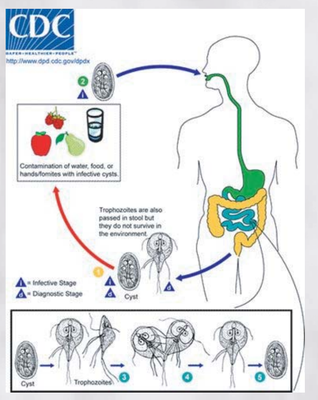
Edison, NJ – Landscaped Commercial (LC)

Edison, NJ– Wooded

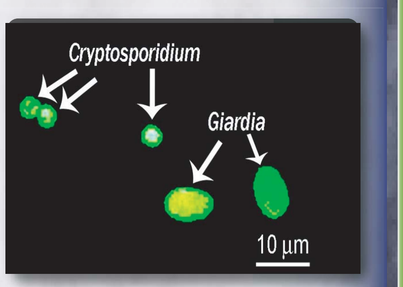
Results

Location		*Cryptosporidium* Per 100L	*Cryptosporidium* % R MS	*Cryptosporidium* % R MSD	*Giardia* Per 100L	*Giardia* % R MS	*Giardia* % R MSD
Staten Island	a	16	5	10	39	24	11
	b	7*	0	0	5*	0	1
Edison LC	a	7*	52	61	43	24	12
	b	5*	8	14	5*	13	11
Edison Wooded	a	31	25	10	377	33	21
	b	7*	33	18	17	44	34
Holmdel		6*	15	15	79	29	52

*A value of 50% of the detection limit was used in calculating the geometric mean. The detection limit was calculated by dividing 100L by the volume examined.

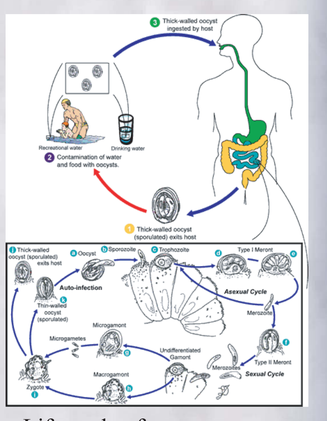


Life cycle of *Giardia lamblia*



Cryptosporidium oocysts and Giardia cysts labeled with immunofluorescent antibodies. Photo Credit: Irwin Katz, US EPA

Holmdel, NJ



Life cycle of *Cryptosporidium parvum*

Conclusions

Cryptosporidium was found in less than 30% of the urban stormwater samples examined.

Giardia was found in 70% of the urban stormwater examined, the highest value at the wooded site (100% pervious) believed due to animals, including deer.

Matrix spike recovery results were variable for both *Cryptosporidium* and *Giardia* due to high particulate matter.

Detection of *Cryptosporidium* and *Giardia* is difficult due to their low concentrations in water, and the labor-intensive procedure of Method 1623.

Quadruplicate analysis yielded excellent precision, except for *Giardia* results for Edison LC (a): geometric standard deviation = 4.35.

References

Arnone, R., Perdek, J., and Borst, M. (2003). Evaluating *Cryptosporidium* and *Giardia* in Combined Sewer Overflow as a Threat to Drinking Water Supplies. EPA Science Forum poster.

Fox, K.R. and Lytle, D.A. (1996). Milwaukee's crypto outbreak: investigation and recommendations. Journal AWWA. Vol. 88, Issue 9, pp. 87-94.

US EPA (2001). Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration/IMS/FA. EPA-821-R-01-025. Office of Water, Washington D.C.

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